MOJAVE RIVER WATERSHED

Interim Survey Report

WRIGHTWOOD
California

Program for runoff and waterflow retardation and soil erosion prevention

U.S. DEPARTMENT OF AGRICULTURE

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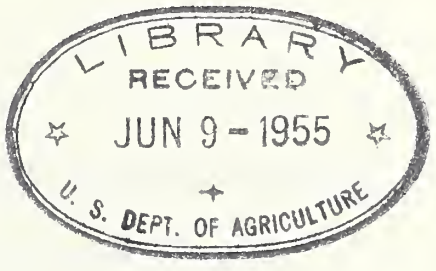
UNITED STATES DEPARTMENT OF AGRICULTURE

INTERIM SURVEY REPORT

Watershed of Sheep Creek,

Tributary of Mojave River at Wrightwood, California



Pursuant to the Act approved June 22, 1936 (49 Stat. 1570),

as amended and supplemented.

August, 1953

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INTRODUCTION

Authority. This negative interim survey report is submitted under the provisions of the Act approved June 22, 1936 (49 Stat. 1570) as amended and supplemented.

Scope. The area considered in this report is the community of Wrightwood, California. Wrightwood is located on the valley lands of Sheep Creek, a small drainage tributary to the Mojave Basin. (Map 1.) The Sheep Creek drainage is about 13.3 square miles in area. The flood, sediment and debris sources consist of two minor tributaries of Sheep Creek covering an area of about one square mile of geologically unstable fault gouge material.

There is no known practical plan of land treatment for stabilization of the source area and, consequently, no watershed land treatment is proposed. This report presents the results of a survey and describes the plans which were considered for the protection of the Wrightwood area.

Need for Protection. Damages from past floods and mudflows have been concentrated in the vicinity of Wrightwood in Swarthout Valley. The community was developed as a resort subdivision. Damages are the result of two types of flow - (1) mudflows, and (2) debris laden flood waters. The mudflows of a consistency resembling concrete mix are caused by saturation of the unstable fault gouge material in the headwaters of Heath and Sheep Canyons. Cloudbursts or heavy rains have occasionally carried sediment and debris laden flows from Oak (Acorn Canyon) through developed portions of the community.

Average annual damages are estimated at $73,070 - long-term projected prices. This damage estimate is based on existing and expected urban developments.

RECOMMENDATIONS

The survey upon which this report is based reveals the following: (a) stabilization of the damage source areas cannot be accomplished by the protection works described herein because of the unstable nature of the source material and the physical location of the damages with respect to source areas, and (b) the installation of either one of the plans described herein, by creating a false sense of security, might cause serious loss of life and aggravated property damage, and (c) no agricultural lands or agricultural problems are involved. In view of the foregoing, it is not recommended that either plan (A) or plan (B) as described herein for the protection of the Wrightwood area be authorized under the flood control act.

DESCRIPTION OF WATERSHED

Sheep Creek, some 60 miles northeast of Los Angeles, is a minor headwater tributary of the Mojave River Basin in Southern California. Its drainage basin, 13.3 square miles in area, is located on the north-facing slope of the San Gabriel Mountains in San Bernardino and Los Angeles Counties. The watershed is entirely within the exterior boundaries of the Angeles National Forest. Six and one-half square miles or 49 percent of the watershed is in private ownership, practically all of which is within the Wrightwood area.

Swarthout Valley, which is drained by Sheep Creek, is a narrow, gently sloping valley lying between two high mountain ridges. Portions of this valley are now developing into residential areas. The town of Wrightwood is the center of development. Draining into Sheep Creek from the south are six small tributary streams, namely Government Creek, Buford Creek, Flume Canyon, Oak Canyon (sometimes called Acorn Canyon), Heath Canyon, and Sheep Canyon. Headwaters of all these canyons are in the high mountain area locally known as the Blue Ridge. The gradients of these drainages are exceedingly steep, approaching 2,000 feet per mile, and in many places exceeding the natural angle of repose. Over 85 percent of the drainage area consists of steep mountains.

On the south side of the valley, the main mountain mass rises abruptly 2,400 feet above the valley floor. The valley proper lies at an elevation of about 6,000 feet. Blue Ridge, forming the south side of the drainage, is deeply incised by the precipitous canyons mentioned above, which average about one and one-half miles in length. The north

slope of the valley, elevated about 750 feet above the valley floor, is short and generally uniform without sharply defined lateral drainages.

The physiography reflects the geologic development of the area, which is characterized by a zone of very active faulting. The San Andreas fault, extending from the Mexican border to north of San Francisco, determined the alignment of Swarthout Valley. The area is characterized by great horizontal movements, a wide zone of crushing, and numerous branching and lateral faults, all typical of this extensive fault zone. The San Andreas fault traverses the entire length of Swarthout Valley. The mountain block forming the headwaters of Sheep Creek reflects the tremendous crushing force resulting from the extensive movement along the San Andreas and branching fault lines.

The geologic formation of this mountain mass consists of a blue-gray mica schist of the Pelona series, which has been severely shattered and, in certain zones, completely broken down to fault gouge material. Because of the shattered nature of the rocks and the instability of the Pelona schist in this steep terrain, extensive land slumping and sliding have occurred in the headwaters of Heath Canyon. Oak Canyon is affected to a lesser extent. Unstable soil and rock formations characterize all the headwaters of tributaries draining the north-facing slopes of the Blue Ridge. Land conditions of all these areas affect developments in Swarthout Valley.

Heath and Oak Canyons, two adjacent small tributaries, are the contributors to the mud and debris flow damage in Wrightwood. The total watershed area comprises less than one square mile, or about 7

percent of the entire Sheep Creek drainage. Within these canyon watersheds the flood and mud source area occupies about one-quarter square mile or about 2 percent of the watershed area.

The soils of the watershed are of recent origin and have been classified in three broad groups based on the geologic origin of the parent rock. The soil of the south slopes is a rocky sandy loam forming a thin covering over the deeply weathered mica schist. Under optimum cover conditions this soil has a high permeability and low erodibility. The soil of the north slope of the valley is a gravelly sandy loam derived from metamorphosed rocks, gneisses, schists, and sediments. Soils range in depth from practically none to 3 feet. They are relatively high in permeability and erodibility. The soil of the remainder of the area is recent alluvial material. Because of its recent origin and its nearness to the source areas, this soil tends to be coarse and rocky.

The broad vegetative types of the drainage, in percent of area, are as follows: pine-fir, 60 percent; sage, 20 percent; pinon pine, 10 percent; shrub, 7 percent; cultivated, 1 percent; and barren, 2 percent. On the south side of Swarthout Valley sage covers the valley floor. Jeffrey pine occupies the lower slopes and alluvial fans; sugar pine, Jeffrey pine, and white fir dominate the upper slopes. The north side of the valley is covered by pinon pine type, intermixed with shrub species. The average density of the cover is about 55 percent, ranging from 40 percent in the pinon pine type to 75 percent in the Jeffrey pine type on the alluvial fan of Acorn Creek. Environmental conditions are severe due to the dry summers, steep slopes, and unstable geology.

This combination is not conducive to the ultimate improvement of vegetative cover. Snow slides are common. They have been responsible for perpetuating some of the barren slopes, destruction of trees by breakage, and the abandonment of cabins in Sheep Canyon. This combination of unstable geologic formations, almost vertical slumps, and the prevalence of snow slides precludes revegetation as a feasible method of erosion control for the present problem area.

The variations in character and type of the native vegetation reflects the variations in climate. Conditions are due in part to the wide differences in elevation and exposure within this small watershed. The climate varies from semi-desert type in the lower reaches of the watershed to temperate in the valley area. The average annual precipitation at Wrightwood Village is approximately 30 inches, part of which occurs as snow during the winter storm season. On the slopes above the valley it may be 5 to 10 inches greater. Precipitation is generally light in summer months. The exceptions are the thunderstorms which sometimes strike the area with high-intensity rainfalls of very short duration.

Physical conditions in the watershed, such as the presence of large masses of shattered rock formations on exceedingly steep slopes, make the valley areas subject to danger from disastrous flood flows. These may be caused by either snowmelt or torrential summer storms. If earth movements occur during a period when the loose material on the slopes is saturated with water from rain or melting snow, it is quite possible that most of the Wrightwood area would be severely damaged. Few communities are so dangerously exposed to a set of geologic and climatic conditions which are threatening disaster.

FLOOD PROBLEMS

Flood Damage. Damage from past floods has been concentrated in Wrightwood Village by the mud and flood flows from Heath and Oak Canyons. In Sheep Canyon, adjacent to Heath Canyon, all cabins have been destroyed by snowslides or heavy snowpack, and the entire development has been abandoned. The major drainage traversing the length of Swarthout Valley has in the past caused damage to the State highway. The remaining tributaries within the watershed are undeveloped and damages have been negligible.

The area subject to flood damage comprises about 370 acres, located in Wrightwood Village. At 1946 prices, the value of the lots, including roads and utilities, is estimated at $900,000. Up to 1946, since opening the tract in 1924, 375 houses valued at $1,200,000 have been built. House furnishings represent a value of about $181,000. The total value of the tract, including commercial buildings, is about $2,325,000.

The value of the tract 60 years hence, when the village is assumed to have reached maximum development, is estimated to be in excess of $6,000,000. Based on trends of the past 20 years, it is estimated that within the area now developed 1,000 houses will be built during this period, representing a value of $3,700,000, including furnishings.

Accurate damage data for Wrightwood are not available except for the mudflow from Heath Canyon in 1941, which was estimated at $30,000. Damage was relatively light as the flow was deflected to the east of the development by a low dike, built after the 1938 flood. Three houses

in the path of the flow were destroyed as were two acres of apple orchard and the value of 64 lots. A short section of the Lone Pine Road was covered with debris more than 6 feet deep.

The September 1945 thunderstorm was of short duration and caused little damage in the Heath Canyon area. The flow was confined to the 1941 mudflow area. The total damage, estimated at $2,500, consisted of mudflow deposition on undeveloped lots, deposition of more debris on Lone Pine Road, and the destruction of one residence. Local residents estimate the damage for the adjacent Oak Canyon area at $5,000.

The March 1938 flood followed a course through the center of development in the Heath Canyon area. The Oak Canyon flow divided at the mouth of the canyon, the greater flow traversed the more densely developed eastern portion of this overflow area, and the lesser flow followed a western channel. Damage in both areas was extensive. House foundations were undermined through bank and gully cutting, debris was deposited in and against houses, septic tanks and sewage filter beds were inundated or silted. State Highway No. 2 was covered with debris and closed for several days. Village streets were gullied and required releveling and cleaning. The flood caused considerable inconvenience to residents through temporary loss of use of their properties. Estimate of flood loss by local residents was $20,000. This damage was re-evaluated to reflect 1946 development, watershed conditions, and values.

Construction of houses in Wrightwood since 1938 and the efforts of individual residents to deflect flows from their properties have only

increased the possibility of greater damage from future floods. Continued slumping of great masses of material in the headwaters of Heath Canyon provides almost unlimited amounts of debris for discharge by future flood flows. The dike from the mouth of Heath Canyon to the highway is inadequate in its present condition to withstand another major flow. Failure of the dike would concentrate the flow through the 1938 overflow area below Heath Canyon, resulting in a material increase in damage.

The probable overflow area was assumed, for reappraisal purposes, to be identical with the 1938 area. This area was mapped and the values of the individual properties were appraised. The degree of susceptibility of flood damage was determined and the damage expressed as a percent of the value of the respective property. The total damage from a flood of 1938 magnitude is estimated at $89,000, assuming 1946 conditions and prices. The damages to residences caused by undercutting of foundations, destruction by boulders, flows filling houses with debris, and flooding with heavy siltation, flooding of buildings and cesspools, and destruction of landscaping and driveways would amount to $75,800. Damage to business was estimated to be $1,400 and to roads and utilities, $11,800.

Future flows from Heath Canyon may occur as either mud or flood flows. Estimates of damages also have been made for a mudflow of the magnitude of 1941 following the path of the 1938 flow. This type of flow is estimated to render unusable 28 houses, causing damage of $66,100. Another 66 units would be damaged to varying degrees at a

loss of $34,800. Damage to lots would be $42,700 and to roads, $13,400. The total damage caused by a mudflow of this magnitude from Heath Canyon is estimated at $198,900.

The estimated damages in the two canyons apply to the most probable overflow areas. However, at least two alternative courses exist in either canyon for flows of the 1938 magnitude. In Oak Canyon the threat of mudflow is not so imminent and the flood flow damage would be about the same regardless of the course followed. Damage in Heath Canyon overflow areas would be relatively small if the flow followed the same path as in 1941. Damage on alternative flood routes would be almost as high as in the probable overflow area. The average damage from a 1938 magnitude flow, taking into account the alternative courses and the probability of flows in Heath Canyon occurring as either flood or mudflows, is estimated at $113,400 for both canyons. Indirect damage would result from the destruction of cesspools, closing of roads and highways and interruption of traffic on state and local transportation systems, interruption to communication systems, loss of wages due to the inability of residents to reach centers of employment, loss of business, evacuation of houses and other buildings, and relief costs. The indirect losses may equal or exceed the direct losses during a flood of the 1938 magnitude but in the average it will be about 50 percent of the direct losses.

Because of its peculiar location at the foot of a steep mountain covered with a mass of loose material, Wrightwood is exposed at all times to unusual hazards to life and property. Present developments are built upon a steep gradient debris cone, the head of which is

dissected by numerous shallow channels. Heavy debris flows may block any one of the channels and divert the flow to another channel, increasing the probability of concentrated flows and greater damage. The 1938 flow covered almost one-third of the potential overflow area. Greater floods may affect the entire overflow area.

Damage to future developments was determined by multiplying the average annual direct damage per house in each overflow area by the number of houses expected to be built each year during the next 60 years and discounting the values to the present. Total average annual direct and indirect damages in the future, taking the expanded development of the community into account, are estimated at $73,070 (long-term projected prices).

Land Factors Affecting Flood Problems. At present the main sources of flood and debris are two slide areas in the upper portions of Heath and Oak Canyons. These areas, which are now in the nature of raw, moving land masses, illustrate the instability of the severely crushed fault zone in this watershed. The possibility of severe storms greatly enhances the prospects of far greater flood flows and debris movements than have yet occurred. It is fortunate that some form of plant cover still exists on the remainder of the drainage basin and in the other small tributary watersheds. Without the existing protective cover, critical flood and debris source areas would be much greater than at present.

Present land practices, particularly on Federal lands, are resulting in a general improvement of watershed conditions. At present there is no farming nor open-range grazing of livestock. There is

some timber cutting for fuel wood in the forested portions of the relatively level lands in the valley. A very small amount of land on the valley floor is under fenced grazing use.

Fire history since establishment of the National Forest has been remarkably good. Records dating from 1911 show a total of 265 acres burned in the 35-year period, or an average annual rate of burn of 0.1 percent, well within the standard established for southern California watersheds. Fire scars on older trees, however, indicate the occurrence of large fires in the past. One such severe fire burned over the entire watershed almost 60 years ago. Extensive fires and grazing either independently or in association with snow slides may have initiated the now greatly accelerated soil and rock movement in the unstable fault zone in Heath and Sheep Canyons. Present fire-control efforts appear to be adequate for the maintenance of good cover conditions in the interests of flood prevention. It is possible that future increased occupation of the valley may require a higher degree of fire protection.

ACTIVITIES RELATED TO FLOOD CONTROL

Existing flood-control works consist of temporary dikes to divert flood flows from the developed area below Heath Canyon and to protect State Highway No. 2. After the 1938 flood the State Highway Department constructed an earth enbankment diversion 3,000 feet long to protect the state highway northeast of Wrightwood Village. This dike functioned satisfactorily during the 1941 and 1945 floods.

A similar dike was constructed in 1938 by local interests and San Bernardino County from the mouth of Heath Canyon extending for a

distance 1,700 feet downstream in an attempt to divert flows from the developed area below Heath Canyon. The length and height of the dike proved inadequate during the 1941 flood after which it was repaired and extended to the Lone Pine Road, a new total length of nine-tenths mile. The dike was again breached in the flood of 1945, permitting the recurrence of damages to Wrightwood. In 1946 a new dike was constructed above the 1945 break and located farther to the west. The present structure is of the same length and has a height ranging from 5 to 7 feet. The present location alters the direction of flow at the mouth of Heath Canyon, deflecting the channel at an angle of about 30 degrees. However, bank cutting of the dike itself and aggradation of the channel from the canyon mouth to the highway indicate the inadequacy of the measure for permanent protection.

No other plans for the further flood protection of the area are known.

PROTECTION PLANS STUDIED

As pointed out in other sections of this report, the problem is limited to the protection of an urban area against flood and debris flows arising from geologically unstable fault gouge material occupying only 2 percent of the watershed area. So long as the existing plant cover on the remaining tributary area remains unimpaired, no special land treatment program would be needed. At present the only means of providing protection would involve downstream structural works on Oak (Acorn) and Heath drainages which directly contribute to the damage areas in Wrightwood. Two plans involving structural improvements referred to as Plans "A" and "B" were considered.

PLAN "A"

The structural improvements in plan "A" are designed to provide the developed Heath and Acorn Canyon overflow areas with effective protection against damages from floods greater in magnitude than the 1938 flood. They consist of one debris basin each at the mouths of Heath and Acorn Canyons, together with a concrete spillway and a concrete lined outflow channel leading from each basin to Sheep Creek which drain Swarthout Valley.

At Heath Canyon the dam would be approximately 480 feet long and 70 feet high, with a storage capacity of some 700,000 cubic yards. The concrete lined channel would be approximately 3,300 feet long. The Acorn Canyon dam would be approximately 800 feet long and 20 feet high, providing storage for about 65,000 cubic yards of debris. The concrete spillways and channels are designed to pass the maximum probable flood.

Total estimated installation cost for plan "A", including rights-of-way, is $1,454,860 (long-term projected prices). Annual maintenance and operation is estimated at $23,250.

All lands in the canyons above the two basins would be restricted to deposition and floodways, and existing developments within these areas would have to be abandoned. It would be essential at all times to maintain sufficient capacity in both basins and concrete lined channels for deposition of debris from the largest expected floods to assure effective functioning of the protection works. This would require removal of debris after each flood. Debris storage areas below the two structures would be required for the material removed from the basins after each flood.

The possibility exists that future geologic disturbances affecting Acorn Canyon may cause a large increase in the extent and rate of land slumping similar to that which has already occurred in Heath and Sheep Canyons. In that event, additional protective measures would become necessary. No provision is made for this contingency.

The structural measures in plan "A" if properly maintained would largely eliminate the recurrence of damages from future flows in that portion of Swarthout Valley below the proposed measures. It should be noted, however, that the structures would not protect developments above the debris basin in Acorn Canyon itself. As there is no way whereby these developments could be provided any protection, they would therefore have to be abandoned.

No increase in value of properties could be expected from flood protection. The Wrightwood area is now in its highest use. Present building construction is proceeding irrespective of the flood danger, and property values at present are not affected by the flood hazards. Total benefits from the program would therefore consist entirely of reduction in flood damages.

PLAN "B"

The improvements considered in plan "B" are not as costly and would not afford the same degree of protection as the improvements in plan "A".

Plan "B" consists of the construction of earth channels leading from Heath Canyon and Acorn Canyon to Sheep Creek which with earth

dikes would be capable of carrying debris flows from a flood of about a 25-year frequency.

The channel from Heath Canyon would be about 6,000 feet long and that from Acorn Canyon about 5,000 feet long. The earth dikes would be the same length as the channels and, in Heath Canyon, they would vary from 5 to 15 feet in height and in Acorn Canyon from 10 to 20 feet in height.

Debris removal immediately after each flood would be essential in order to maintain the effectiveness of the structures against a flood which may occur once in 25 years. This plan would not provide protection against disaster to life which could be caused by a flood greater in magnitude than the flood which occurs on the average once in 25 years. A flood of such greater magnitude could occur at any time after the completion of the structures, with the possibility not only of destroying the protective work but also of causing serious loss of life and aggravated property damage. It is even possible for damage and loss of life to result from a flood of low discharge if it occurred before the debris from a previous flood had been removed from the channel. Since several floods could follow each other at rather close intervals, it would be essential to maintain equipment at or near enough to the improvements to permit the removal of debris immediately after each flood. Debris storage areas would be required for the material removed from channels after each flood.

Total estimated installation cost for plan "B", including rights-of-way, is $357,780 (long-term projected prices). Annual maintenance and operation is estimated at $3,670.

OTHER CONSIDERATIONS

Considerable damages and probable loss of life would be likely to occur should additional developments be undertaken in the future in high flood hazard areas. In the light of present experience and current knowledge of the highly unstable physiographic and geologic conditions in the watershed, it would be essential that all future developments in potentially high hazard areas be prevented.

In order to accomplish this fundamental objective, non-use or local public control would be required for undeveloped lands that lie in the path of flood flows. These are the overflow areas of tributaries to Sheep Creek (including Flume, Buford and Government Canyons) the main Sheep Creek channel area, and the Sheep Canyon tributary area.

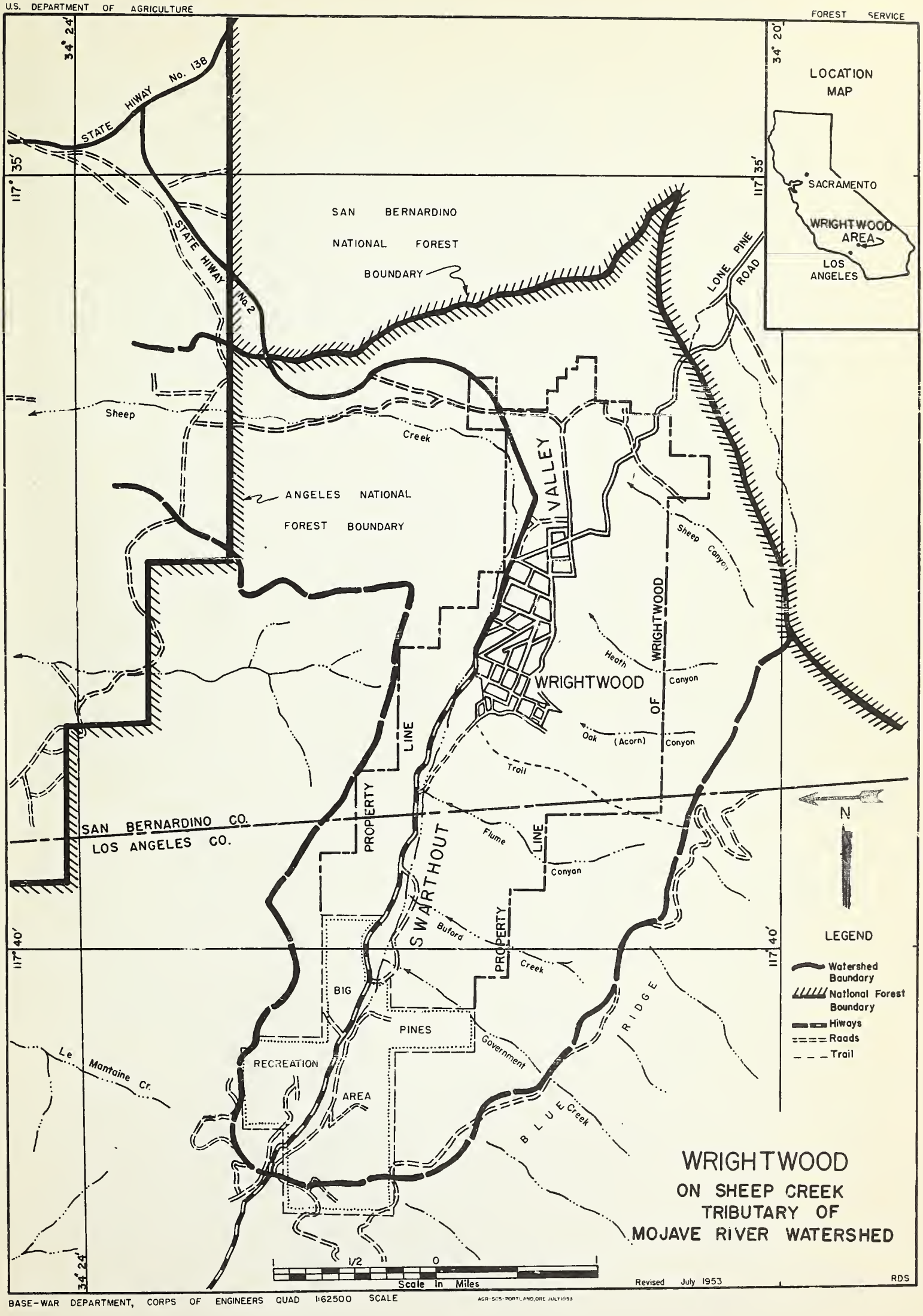
Widespread slumping has already occurred in the Sheep Canyon tributary area at the southeast end of the Sheep Creek drainage in San Bernardino County. Its usefulness for immediate economic development has been destroyed. This area, representing the most critical and severely deteriorated source of flood and debris flows in the watershed, has been currently abandoned as the result of slides and mudflows. It is now in an active stage of deterioration. There is grave danger, however, that newcomers to the area might have a false sense of optimism and security during some flood-free period, inducing attempts at re-occupancy. The best means of preventing such attempts would be for the entire drainage of about 430 acres now in private lands to be zoned or controlled by some public agency.

Once these lands were publicly controlled it would be the recognized duty of the administering agency to close them against all forms

of habitation and other forms of occupancy and use which could later become a threat to life, property, or soil stability in this watershed.

The high level of forest fire control which currently exists appears adequate to maintain the watershed protective value of the plant cover. However, with the completion of a road providing direct access to Swarthout Valley from Los Angeles and with it the expected increased development and use of Swarthout Valley, the forest fire hazard will undoubtedly increase. Despite precautions, it is possible that a fire might break out in the watershed, thus aggravating the present situation.

Aside from fire, the only other foreseeable threat to the maintenance of an adequate vegetative cover is livestock grazing. This use is at present confined to a very limited portion of the valley floor. However, in order to preclude the possibility of future damage to the cover from this source and the exposure of erodible material, grazing should be completely excluded from the entire Sheep Creek watershed.


U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
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STATE HIWAY No. 138
STATE HIWAY No. 2
SAN BERNARDINO NATIONAL FOREST BOUNDARY
ANGELES NATIONAL FOREST BOUNDARY
LOCATION MAP
SACRAMENTO
WRIGHTWOOD AREA
LOS ANGELES
LONE PINE ROAD
Sheep Creek
VALLEY
WRIGHTWOOD
Sheep Canyon
Heath Canyon
Oak (Acorn) Canyon
Trail
PROPERTY LINE
SAN BERNARDINO CO.
LOS ANGELES CO.
SWARTHOUT
Flume
Buford Creek
BIG PINES RECREATION AREA
Le Mantaine Cr.
Government
RIDGE
BLUE Creek
N
LEGEND
Watershed Boundary
National Forest Boundary
Hiways
Roads
Trail
WRIGHTWOOD
ON SHEEP CREEK
TRIBUTARY OF
MOJAVE RIVER WATERSHED
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Scale in Miles
Revised July 1953
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